THE iRAP PROGRAMME: THE SAFETY EFFECTS OF CENTRAL HATCHING

Alvin Poi Wai Hoong, Jamilah Mohd Marjan
Road Safety Engineering and Environment Research Centre
Malaysian Institute of Road Safety Research
Lot 125-135, Jalan TKS 1, Taman Kajang Sentral,
43000 Kajang, Selangor, Malaysia
alvinpoi@miros.gov.my, jamilah@miros.gov.my

ABSTRACT

The International Road Assessment Programme (iRAP) is developed to help low and middle income countries to identify cost-effective road treatment works through globally consistent methodology. The iRAP Pilot Study in Malaysia was completed in 2007 where over 3600km of roads being inspected. Several countermeasures were suggested to improve safety and such as eliminating roadside hazards and central hatching. For the case study the central hatching countermeasure was selected to be carried out by the Malaysian Institute of Road Safety Research (MIROS) in collaboration with Public Works Department. This study was to examine the effect on safety characteristics of central hatching at the improved sites.

The iRAP web-based toolkit is used to locate sites for the implementation of the countermeasures. Instead of comparing crash data in which significant changes could only be seen over a few years, speed and lateral position of vehicle were used to assess the effects of the central hatching. This paper will attempt to outline the methodology adopted in the study and show the results of the baseline data collected. If such a measure can be shown to improve safety, it can be another cost-effective measure on roads with limited right-of-way as substitute to physical median.

1. INTRODUCTION

The International Road Assessment Programme has been developed to upgrade the safety of the road environment in low and middle income countries in order to reduce the global death toll. [3] Due to the strong commitment shown by the government to improve the current road safety situation, Malaysia was selected as the pilot country for the iRAP initiative in the Asian Region with the help of the local automobile club, AAM. [8] The pilot study was completed in 2007 where more than 3600 kilometers of roads were inspected. One of the outputs generated from this study was the road star ratings with respect to four different group of road users – car occupant, motorcyclist, pedestrian and bicyclist. The star ratings represent the safety of the road infrastructure which relates to the risk faced by an individual of each of the road user group. [4] From the star ratings, appropriate countermeasure programs were recommended.

The implementation of the iRAP study in Malaysia has given the opportunity to the Malaysian Institute of Road Safety Research (MIROS) to investigate the effects of the road environment on road accidents. A study is thus formulated to research the effectiveness of one of the recommended low-cost countermeasure, which is the central hatching. This countermeasure is recommended based on several combinations of triggers such as type of area, traffic flow, number of lanes for through traffic, type of median, presence of pedestrian crossing facilities and the star ratings for car occupants and pedestrian. The main objective of the study is to evaluate the effectiveness of central hatching through mean vehicle speeds and mean lateral position of vehicles with reference to the centreline. The present paper is aimed

at presenting the baseline results for the two parameters before the implementation of the treatment as well as outlining the data collection method adopted. Discussions on the results and problems encountered would also be included.

2. BACKGROUND OF STUDY

Central hatching or more commonly known as painted or flush median is one of the perceptual countermeasures to speeding. They are relatively low cost, non-obtrusive road markings usually involving only paint, gravel or both. [2] Besides reducing conflict, encourage improved vehicle lateral placement and lower speeds, flush medians are also used as part of access management and to provide pedestrians with a place to stop while crossing. [5]

A study in Norway investigated the effects of two types of painted median on driver behavior. The first type consists of transverse 1 m long lines with 1.5 m distance between them. The second consists of two longitudinal lines 1 m apart. Both types of painted medians resulted in increased separation between opposing traffic streams by 60 to 72 cm, compared to a conventional centreline. In addition, a speed decrease of 2.7 km/h was found for the second type. [7]

A few experiments were conducted by the Monash University Accident Research Centre in Australia on perceptual countermeasures. An experiment examined the effects of centerline and edgeline treatments. Four combinations of median and lane widths were tested using a simulator. The results showed that reduction in lane widths produce more behavioural changes than reduction in median widths. The introduction of median treatment on straight sections induced slower speeds than the centerline but is not statistically significant. The mean lateral position was closer to the edgeline by 1 cm than the centerline on straight sections. The best combination for reducing travel speeds whilst increasing road safety was found to be a 2.5 m wide lane width road with a 2.3 m wide hatched median.

The Land Transport Safety Authority (LTSA) in New Zealand documented some findings on the effects of installing flush medians on the changes to the number of accidents. The data used for analysis are from the LTSA Accident Investigation Monitoring System where 41 sites were selected based on a few criteria. The findings revealed that installing flush median had among others reduced overtaking accidents by 28.9%. Overall, there was a 19% decrease in accidents at those sites.

Based on the above findings, central hatching has been proven to have the potential to reduce vehicle speed and to increase separation between opposing vehicles on a road, and hence might lead to the reduction of head-on crashes. The effectiveness of central hatching at the proposed locations along the surveyed roads needs to be evaluated to help in road improvement programs at other locations with similar safety problem.

3. THE METHOD

3.1 Study Site

Based on the iRAP analysis, two road sections along the Federal Route 1 in the state of Perak were recommended to be treated with central hatching. Using the ARRB Group Hawkeye Data Viewer and the iRAP web-based toolkit, the exact locations of the road sections were confirmed. Each of these sections is 400m in length, located almost 1.3 kilometer apart. The road section for the study site falls under the jurisdiction of the public works department for Batang Padang.

A site visit was conducted together with the road authority to clarify issues pertaining to the treatment works. In order to maintain lane continuity and consistency, so as to minimize confusion among the road users, the treatment is proposed to be extended to cover a section of about 2.8 kilometers. The proposed section is a 4-lane single carriageway which begins at an intersection and terminates at a bridge. However, the road authority needs to study the proposal before finalizing the treatment section. Table 1 summarizes the existing geometric details of the proposed treatment section.

Table 1. Geometric details of the proposed treatment section.

Chainage (km)	Speed limit (km/hr)	Median type	Shoulder type	Average lane width (m)	Horizontal alignment
0+00 to 0+500	60	Double unbroken line	Paved > 1 m	3.2	Straight
0+500 to 0+700	90	Double unbroken line	Paved > 1 m	3.4	Curved
0+700 to 0+900	90	Double unbroken line	Paved > 1 m	3.6	Straight
0+900 to 1+900	90	Double unbroken line	Paved > 1 m	3.4	Curved
1+900 to 2+800	90	Double unbroken line	Paved > 1 m	3.6	Straight

3.2 Data Collection

This study involved data collection at the study site. The travel speeds of vehicles were collected through the time taken to traverse along the study site. The spots to place the video cameras were properly selected based on the following criteria:

- The spots are safe for the observers to carry out their works.
- The spots provide a good view of the traffic.
- The video cameras can be concealed from the road users.

Due to the site conditions, the third criteria could not be met. Nevertheless, two spots within the study site were identified based on the other two criteria. Two digital video recorders were placed at these spots (Figure 1) to capture vehicles travelling between Position 1 and Position 2, which was 1.3 km apart. The video recordings were then replayed in the lab to record the travel time of the vehicles. The speed of each vehicle was then computed by dividing 1.3 km by the time the vehicle travelled.

In order to obtain speed data from free flowing traffic, travel times were only recorded for the first vehicle in a platoon. This is because such vehicles which have a sufficient headway of at least 100 m, are truly selecting their speeds. [6] Therefore, only the first vehicle in a platoon was considered as the sample. Considering this, a total of 230 vehicle travel times were recorded from two hours of video recordings.

The lateral position of vehicles was measured on the basis of video recordings. Two digital video cameras were placed at two different spots within the study site to capture vehicles travelling on a curved section (Position 3) and on a straight section (Position 4). Based on the spot selection criteria mentioned earlier, suitable spots for the video cameras were chosen so that a good view of vehicles can be captured (Figures 2 and 4) for ease of measurements. Figures 3 and 5 show the view of both the positions from the video cameras. The data collection was carried out on a weekday, from 11 am to 1 pm.

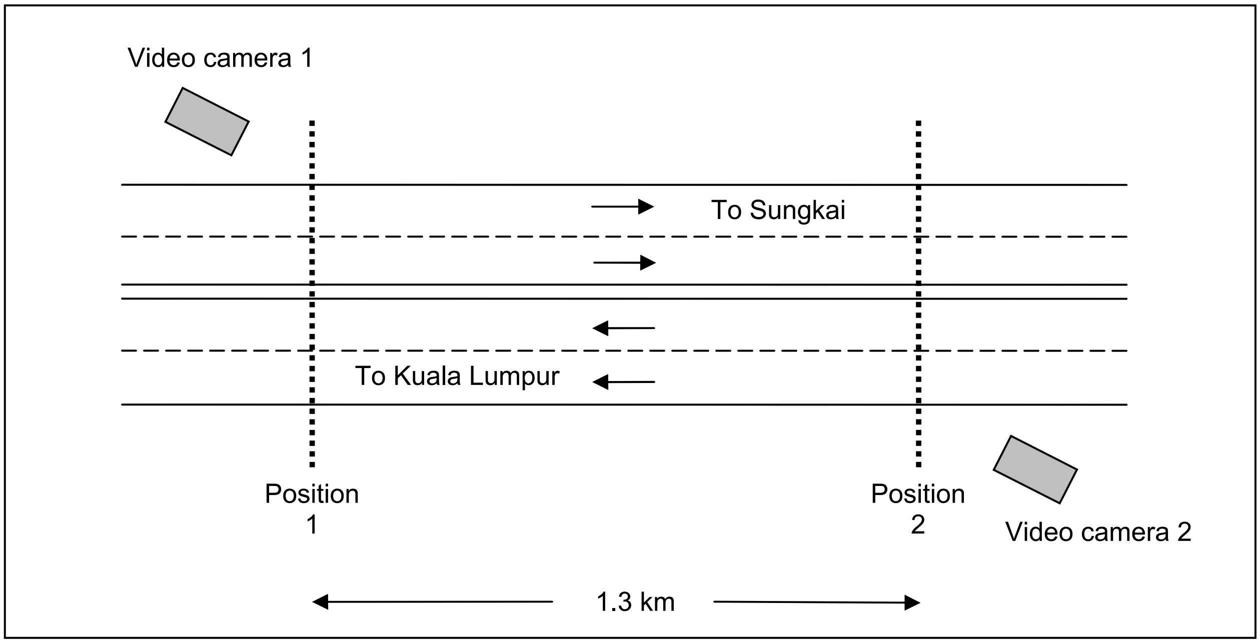

Figure 1. The use of digital video cameras to capture vehicle travel time.

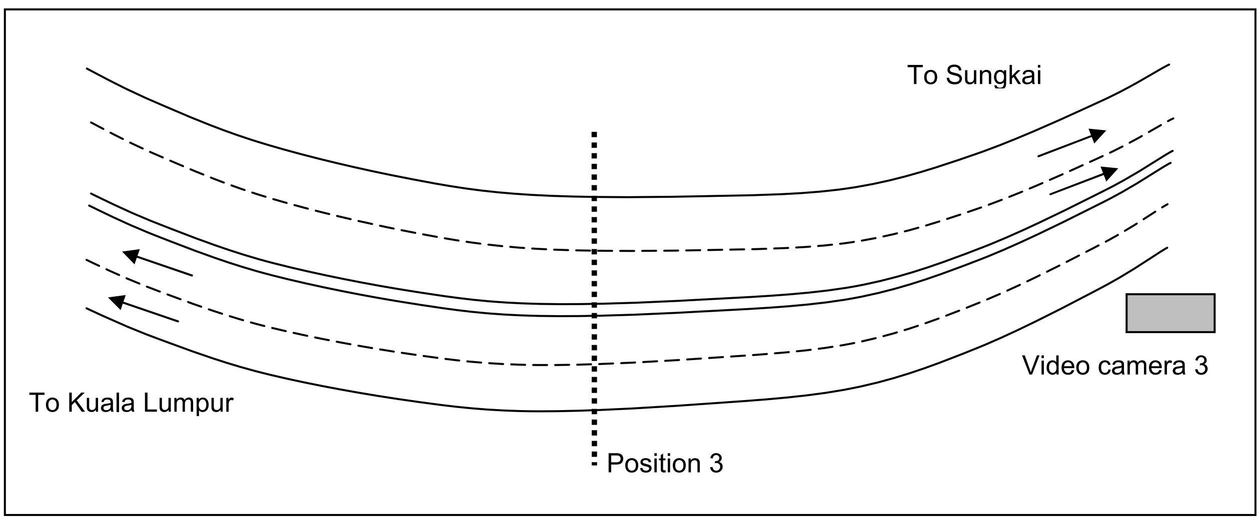

Figure 2. The placement of a video camera to capture vehicles travelling at Position 3.

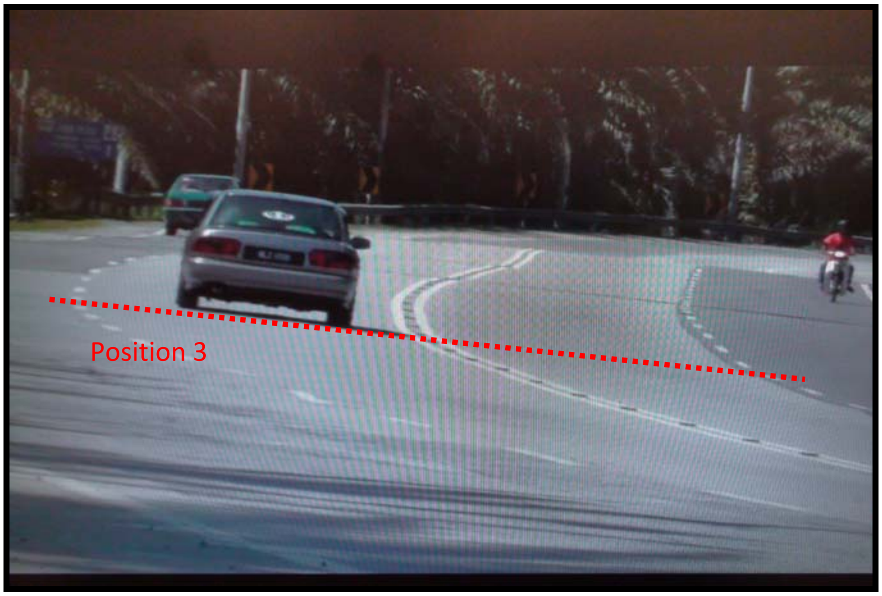

Figure 3. View of position 3 from the video camera.

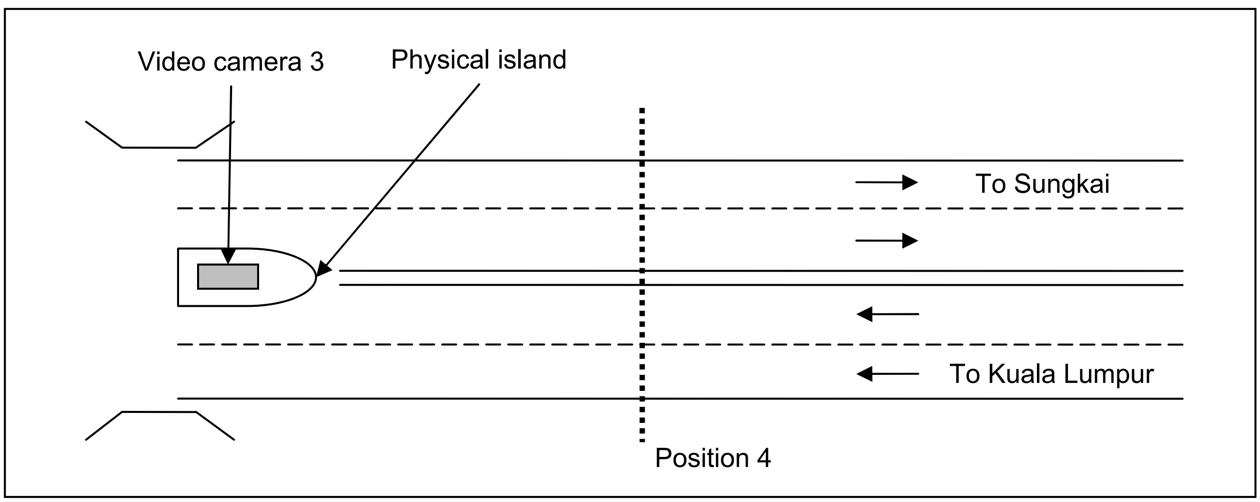

Figure 4. The placement of a video camera to capture vehicles travelling at Position 4.

The lateral position of a vehicle was recorded as distance in centimeter (cm) from the edge of the centerline to the right-side wheel. The measurements were done through a ruler attached to the computer screen (Figure 6). The actual lateral positions for the vehicles were calculated by the following equation:

$$D = d \times \frac{\text{Lane width as measured on site (cm)}}{\text{Lane width as measured on screen (cm)}}$$

Where D = lateral position (cm)
d = distance from edge of centerline to right-side wheel as measured on screen (cm)

Figure 5. View of Position 4 from the video camera.

For Position 3 and Position 4, the samples comprised 450 and 417 vehicles respectively. The data obtained was stored and analyzed using the Statistical Package for Social Science version 15 (SPSS v15). The next section presents the analysis of the baseline data and discusses the problems encountered during the data collection process.

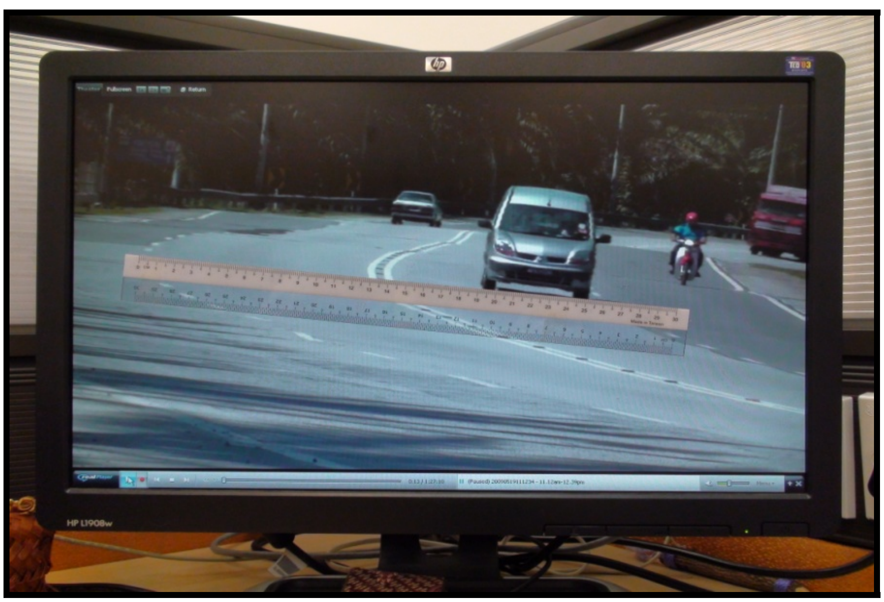

Figure 6. On-screen measurement of lateral position using a ruler.

4. RESULTS AND DISCUSSION

The analysis of data was carried out in the highway and traffic engineering laboratory in MIROS. All the video recordings were first converted into the appropriate format for ease of viewing. The speed data analysis required the use of two computers to record the travel times. Table 2 presents the descriptive statistics for the lateral position and speed.

Table 2. Lateral position and speed data analysis

Statistics	Lateral position (cm)		Speed (km/hr)
	Position 3 (n = 450)	Position 4 (n = 417)	(n = 230)
Minimum	-83	-27	50
Maximum	192	243	118
Mean	82	61	81
85th percentile	-	-	92

4.1 Lateral Position

Based on the minimum values at Position 3 and Position 4, it is proven that there were instances where vehicles were seen encroaching into the opposite lane. These happened when a vehicle on the nearside lane (next to the centerline) was seen trying to avoid another vehicle on the offside lane, especially a heavy vehicle. The maximum values on the other hand indicate that there were also vehicles on the nearside lane that were driven too close to the offside lane. In either situation, there may be risks of collision especially if the drivers are inexperienced. On average, the lateral positions of vehicles at both the sites were found to be less than a meter. With central hatching, these values are expected to be higher.

Table 2 also shows that on average, vehicles travelling at Position 3 were positioned further away from the centerline compared to Position 4. This could be explained by considering the fact that Position 3 was at a curved section and therefore, due to the nature of the centrifugal force vehicles tend to move away from the center of the curve. However, this might also due to the fact that drivers are typically paying more attention when negotiating a curve than driving on a straight section of road [1]. In order to avoid hitting vehicles from the opposite direction, they tend to drive further away from the middle of the carriageway.

4.2 Vehicle Conflicts

As discussed above, there were risks of collision between vehicles travelling in opposing directions as well as between vehicles travelling in the same directions. These were due to presence of heavy vehicles which occupy almost the full width of a traffic lane. In order to avoid being driven too close to them, other vehicles were seen not keeping to their lanes. These included having to encroach into the adjacent lanes which might lead to conflicts between:

(a) a vehicle traveling on the nearside lane with another vehicle traveling on the nearside lane in the opposing direction – conflict at centerline.

(b) a vehicle traveling on the nearside lane with another vehicle traveling on the offside lane in the same direction due to oncoming vehicle in opposite direction – conflict at lane line (Figure 7).

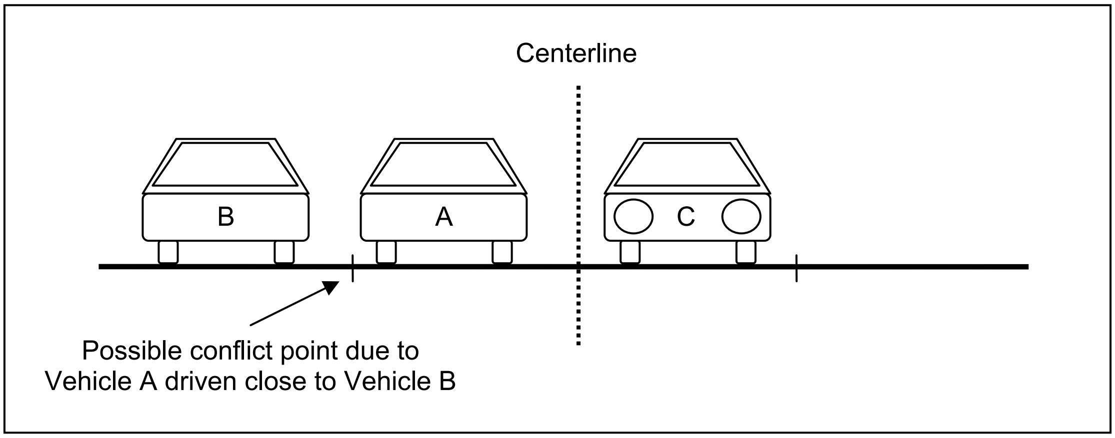

Figure 7. Conflict at lane line.

The use of central hatching is therefore needed to address the above conflicts by means of:

(a) increasing the distance between opposing vehicles to avoid conflict at centerline.

(b) encouraging a vehicle on the nearside lane to keep to its position, thus avoiding conflict with opposing vehicle and vehicle on offside lane due to increased separation (to eliminate conflict at lane line)(Figure 8).

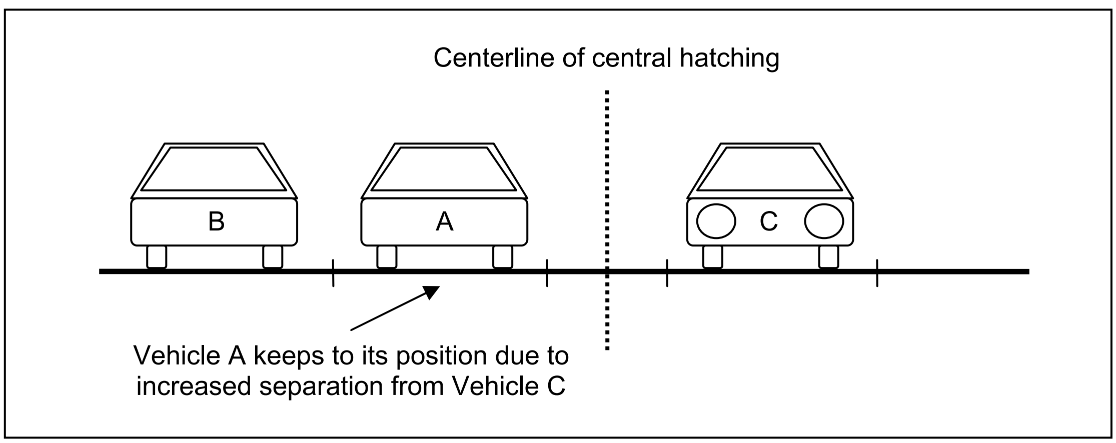

Figure 8. Increased separation between opposing vehicles.

4.3 Speed

The analysis included the speed of all vehicle types except for the motorcycle. It was found that 15% of the vehicles were travelling beyond the speed limit. Almost 5% of the vehicles were found travelling above 100 km/hr, an indication of an unsafe traffic operating characteristics which might be due to factors such as low traffic volume, wide lanes, straight alignments and others. Furthermore, the existence of paved shoulders on the road has provided motorcycles (which are relatively low in speed) a separate path for travelling and thus, the volume of motorcycles on the main carriageway was low. This decreases the level of interaction between low and high speed traffic which in turn increases the possibility of speeding among other vehicles.

The average speed however was found to be below the speed limit. It should be noted here that the study site comprised straight and curved sections where a vehicle's travel might involve acceleration and deceleration. A vehicle speed on a straight section might be higher and sometimes even go beyond the speed limit. Therefore, the use of central hatching can help to encourage lower speed among errant drivers who usually speed up on a straight section. The painting of central hatching later can be expected to create perceptions of narrow lane widths which can affect a driver's behaviour.

The only disadvantage of collecting travel speeds instead of spot speeds is the greater amount of time spent. The exercise involved pausing and playing the video repeatedly to record the time elapsed. In this study, the time spent in the laboratory almost triples the duration of the video recordings at site. However, this can be solved if more man power is involved.

4.4 Limitations of research

The use of video recordings to obtain data on lateral position has quite a few disadvantages. Firstly, the problem of inappropriate angle at which the camera was recording has an effect on the accuracy of measurements. A very suitable spot must be chosen to place the camera in order to capture a good view of the distance between the vehicle and the centerline. The best way to deal with this is to place the camera in the middle of the road but due to impracticality, this should not be carried out. In this study, the cameras were placed close to the edge of the road to minimize the errors of measurements. Therefore, the use of this method in any other research should be carried out with proper corrective actions in order to obtain more reliable results.

The second disadvantage is that during on-screen data collection, the ruler on the screen needs to be adjusted each time the view shifts from the original position. This is due to vibration of the camera caused by vibration in the ground whenever a heavy vehicle passes by. This can be solved if the camera stand be improvised.

The third disadvantage concerns the care of the use of camera. If exposed to sunlight for a long duration, damage to the camera can happen due to the high ambient temperature. A creative way of sheltering the cameras should be thought of so that drivers' distraction is minimized.

5. CONCLUSIONS

The iRAP Hawkeye Data Viewer and the iRAP web-based toolkit were utilized to locate the exact locations for the implementation of central hatching. Two 400m road sections separated 1.3km apart were identified. A site visit was carried out together with the road authority to verify the feasibility of central hatching at the identified location. A thorough study needs to be done by the road authority before finalizing the exact length of the treatment. Based on the initial survey, the site to be treated can be extended up to 2.8km.

The baseline results indicated that there were conflicts at the centerline and at the lane line which showed that there is risk of collision among the road users at the study site. There were two types of possible conflicting situations which are expected to be eliminated with the use of central hatching. The 85^{th} percentile speed at the site was recorded to be slightly higher than the speed limit, which might be due to factors such as low traffic volume, wide lanes, straight road alignment and low level of interaction between high and low speed traffic. The average travel speed recorded was however below the speed limit. These parameters will be compared for the period after the implementation of central hatching to determine if there is any significant change.

The use of video recordings to obtain data has its disadvantages. Suitable spots to place the camera needs to be properly selected so that whilst providing a good view for data collection, it would not attract the attention of the road users. Besides risking the equipment to damage, an improper video recording system can lead to low quality of video playbacks which in turn will affect the quality of the data. More man power is also needed in data retrieval if time is of essence.

REFERENCES

1. Charlton, S.G. 2007. The role of attention in horizontal curves: a comparison of advance warning, delineation, and road marking treatments, *Accident Analysis and Prevention* Vol. 39, pp. 873-885.

2. Godley, S., Fildes, B., Triggs, T. and Brown, L. 1999. Perceptual countermeasures: experimental research. Report No. CR 182, Monash University Accident Research Centre, Victoria.

3. International Road Assessment Programme (iRAP) 2008. Vaccines for roads: the new iRAP tools and their pilot application.

4. International Road Assessment Programme (iRAP) 2009. Malaysia: iRAP Results 2009.

5. Land Transport Safety Authority 1995. Install flush median.

6. Roess, R.P., Prassas, E.S. and McShane, W.R. 2004. Traffic Engineering, Third Edition, Pearson Education International, New Jersey.

7. Sagberg, F. 2007. Effects of a painted median on lateral position and speed: a comparison between two treatments on E6 in Norway. TΦI Report 884/2007, Oslo.

8. Singh, S., Joo Han, T.R., McInerney, R., Hussain, H., Ahmed Ismail, A., and Affum, J. 2007. The International Road Assessment (iRAP) Project: Malaysia Pilot Study. Presented at the 7th Malaysian Road Conference, Kuala Lumpur.